Networks in neuroscience: the problem of stability in the face of constant change

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Networks in neuroscience

- Every individual neuron contains complex networks of interacting biochemical and molecular processes
- The nervous system consists of networks of networks

Neuroscientists attempt to:

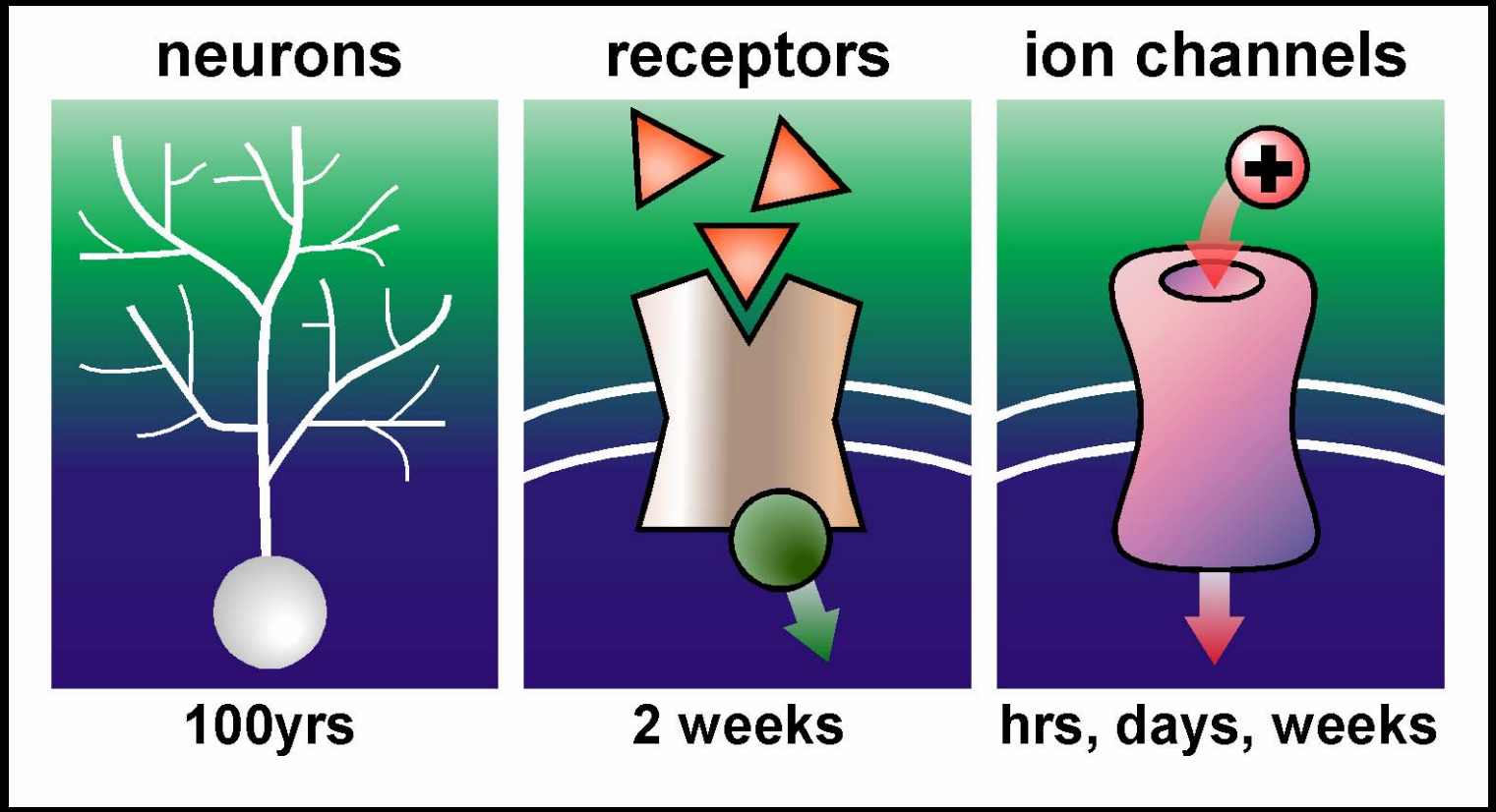
- Determine how functions are localized in neuronal circuits
- Determine the properties of the synaptic wiring and excitability of individual neurons that constitute a network
- Explain how network performance arises from the interactions of the components

The nervous system maintains stable network function while allowing the incorporation of new knowledge that modifies network structure

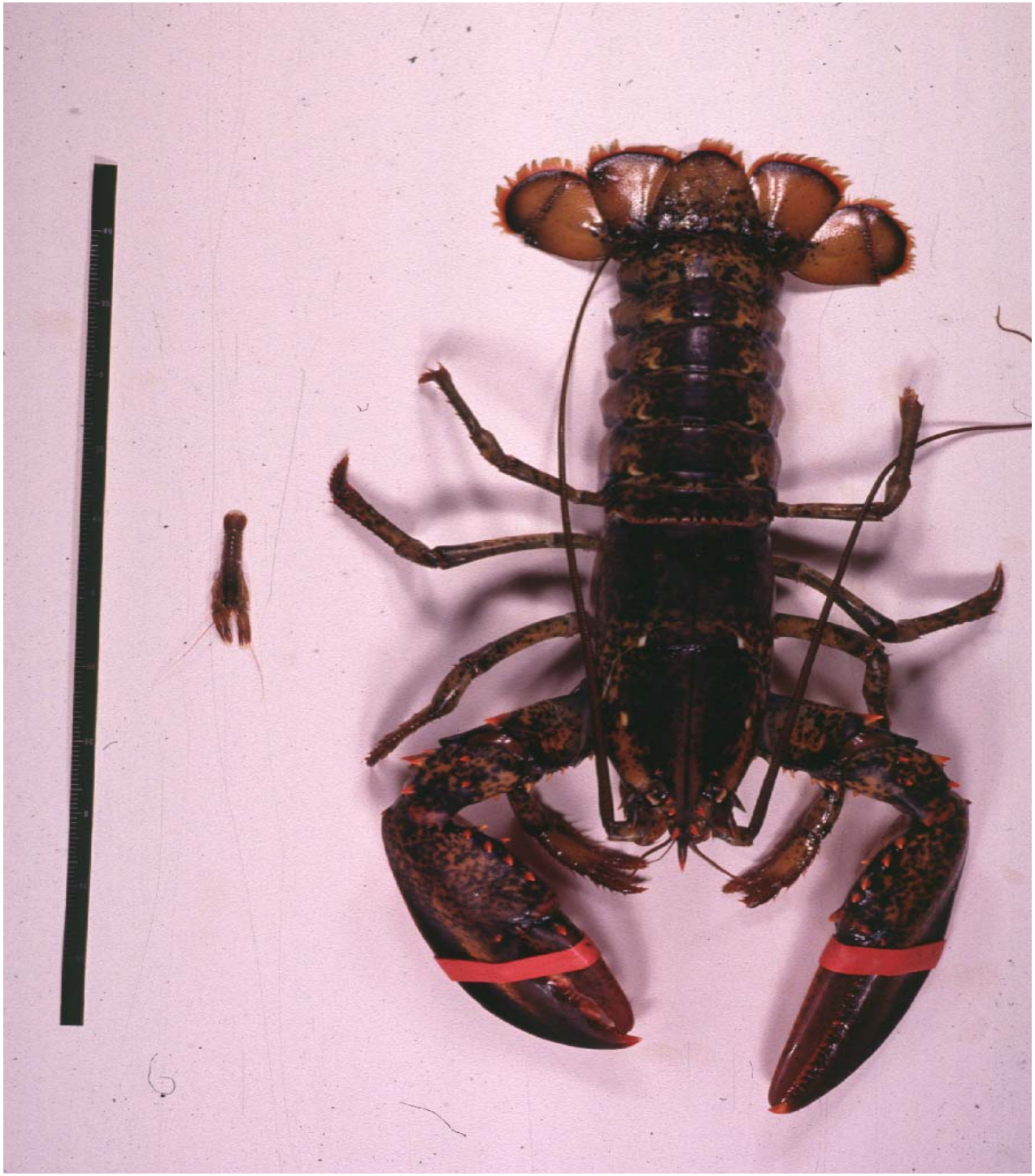
Mental illness can be seen as a failure of the normal processes that maintain network stability

- An ongoing balance between plasticity mechanisms that are required for development and learning (LTP, LTD, etc), and homeostatic mechanisms (synaptic scaling) that stabilize neuronal and network performance.

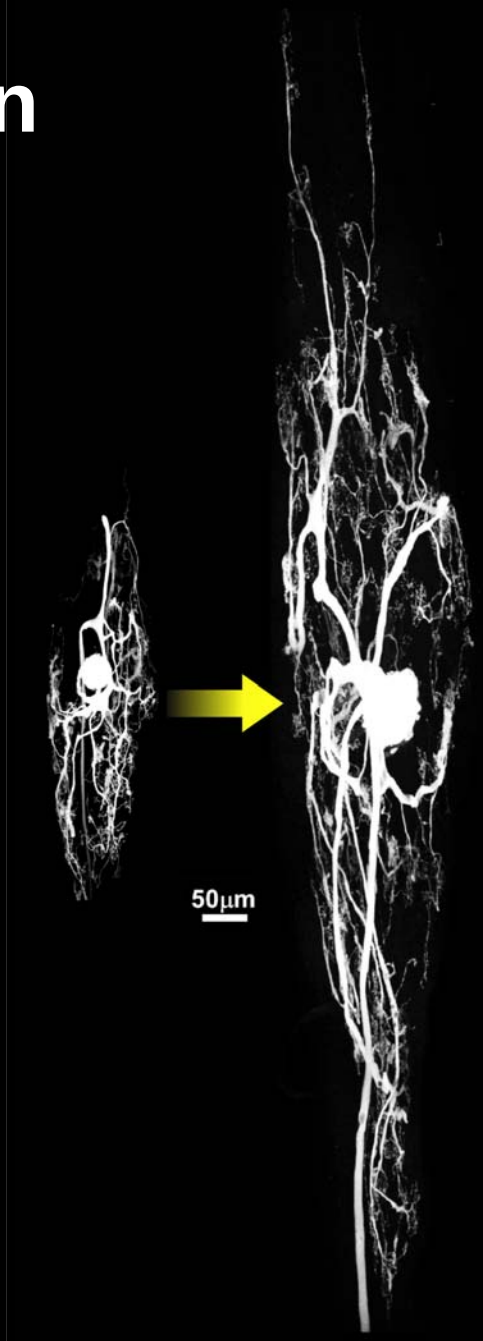
-The components of functional circuits are not static, but are constantly turning over rapidly during the lifetime of a neuron



-How is function maintained while the nervous system is constantly rebuilding itself?



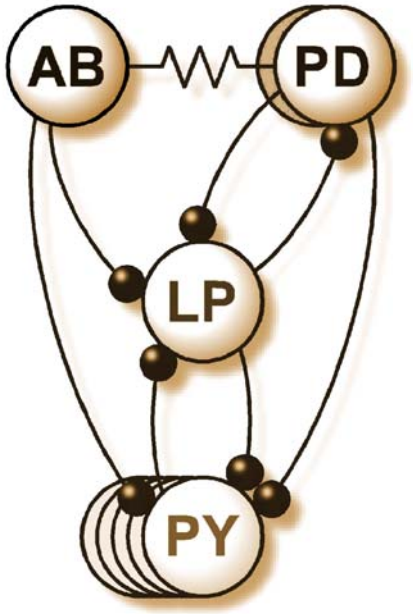
STG neuron growth

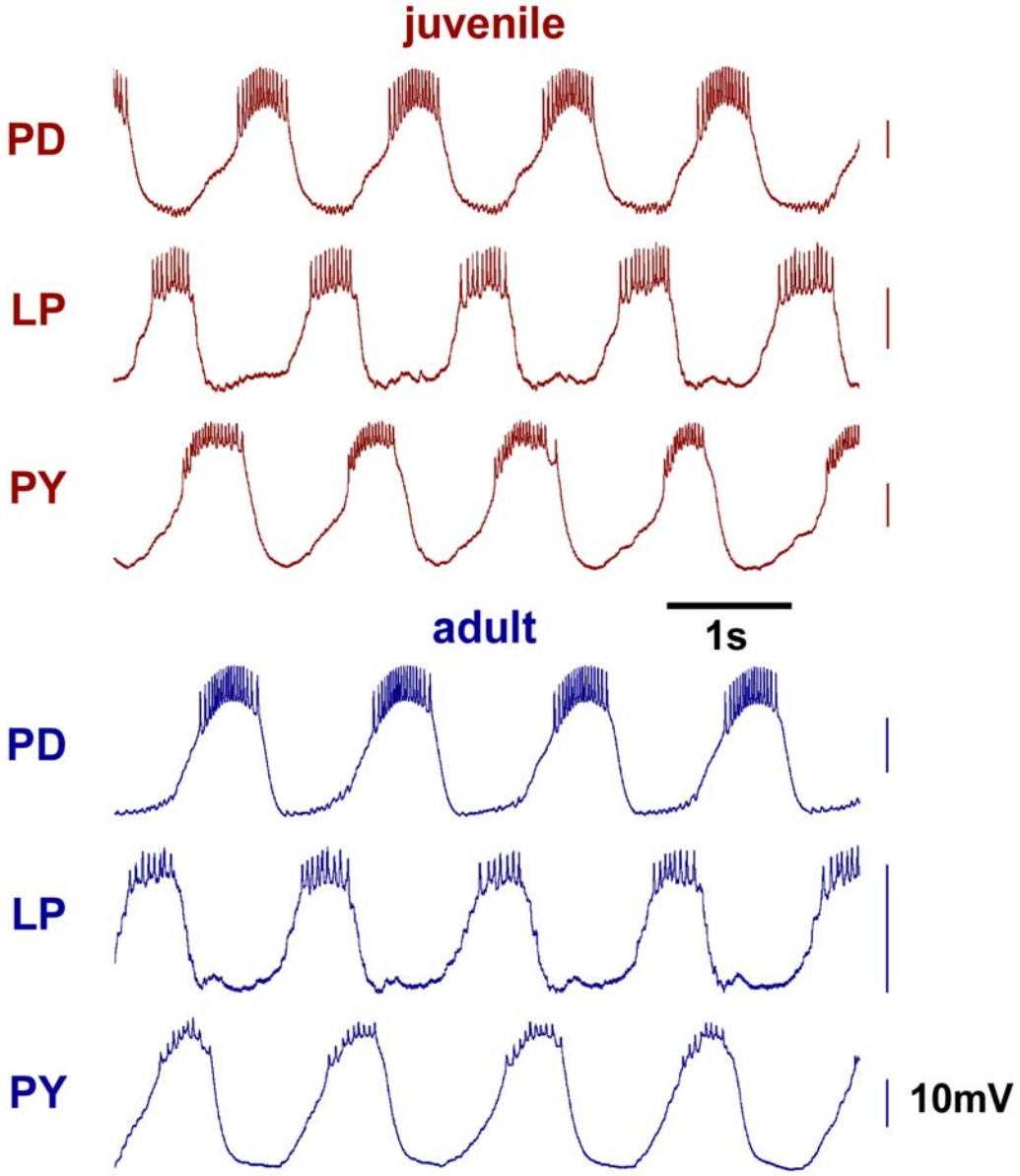


PD, Alexa 568 hydrazide

Bucher D, Prinz AA, Marder E (2005) J Neurosci, 25 (7)

Pyloric neuron waveforms do not change during growth



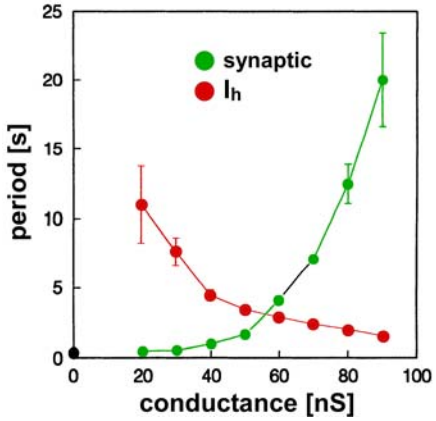


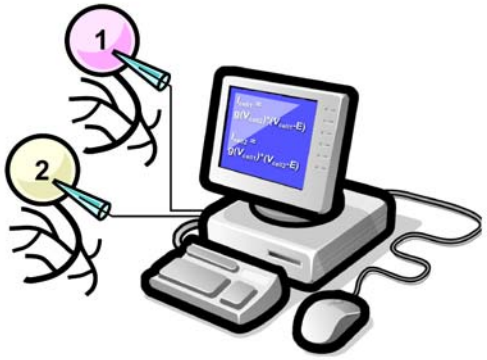
Bucher D, Prinz AA, Marder E (2005) J Neurosci, 25 (7)

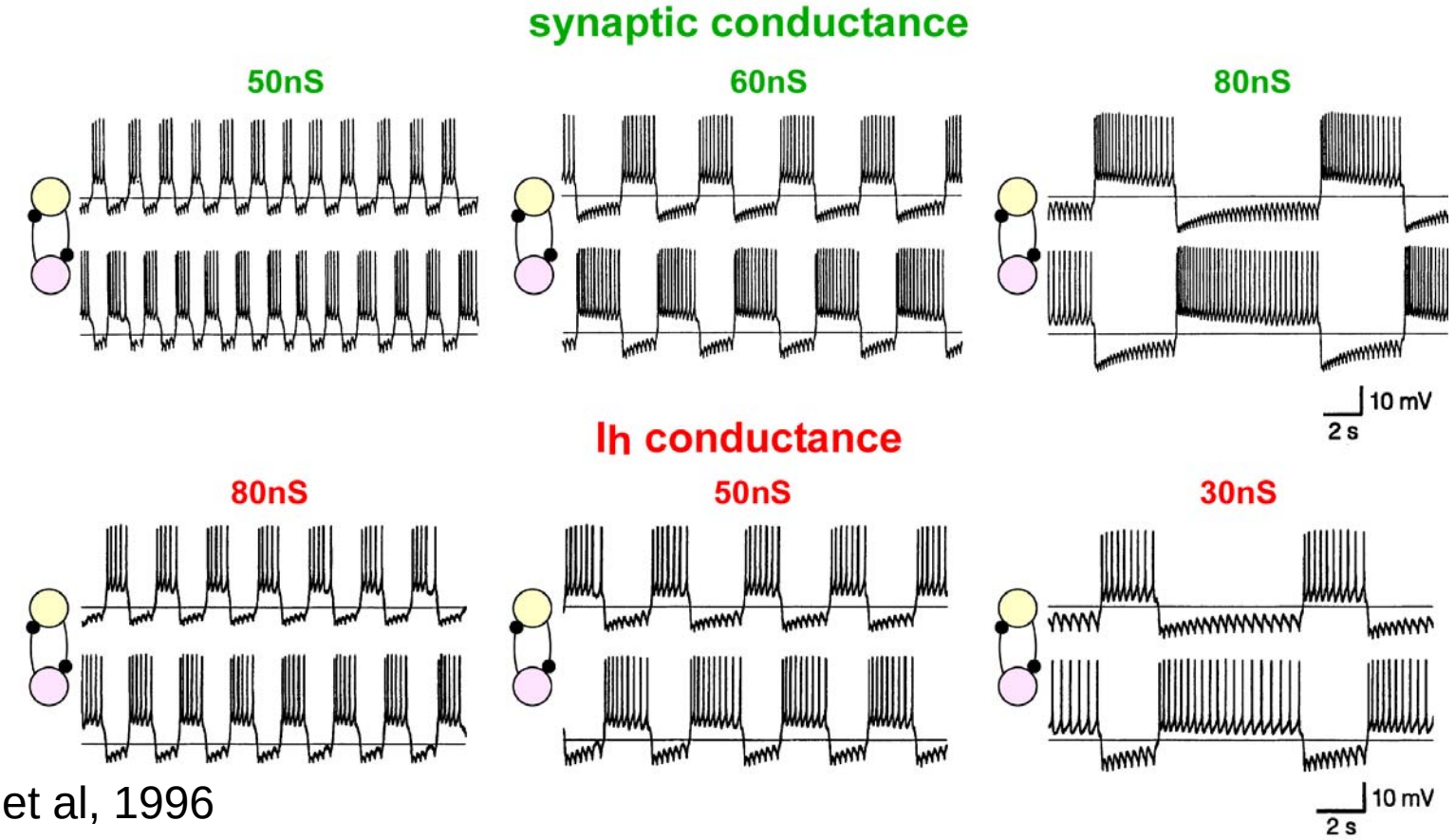
- How tightly tuned do the parameters that govern synaptic strength and intrinsic properties need to be for "good enough" network behavior?

- Understanding the rules that allow compensation in neuronal and network function

Changing either intrinsic or synaptic conductances can alter network function

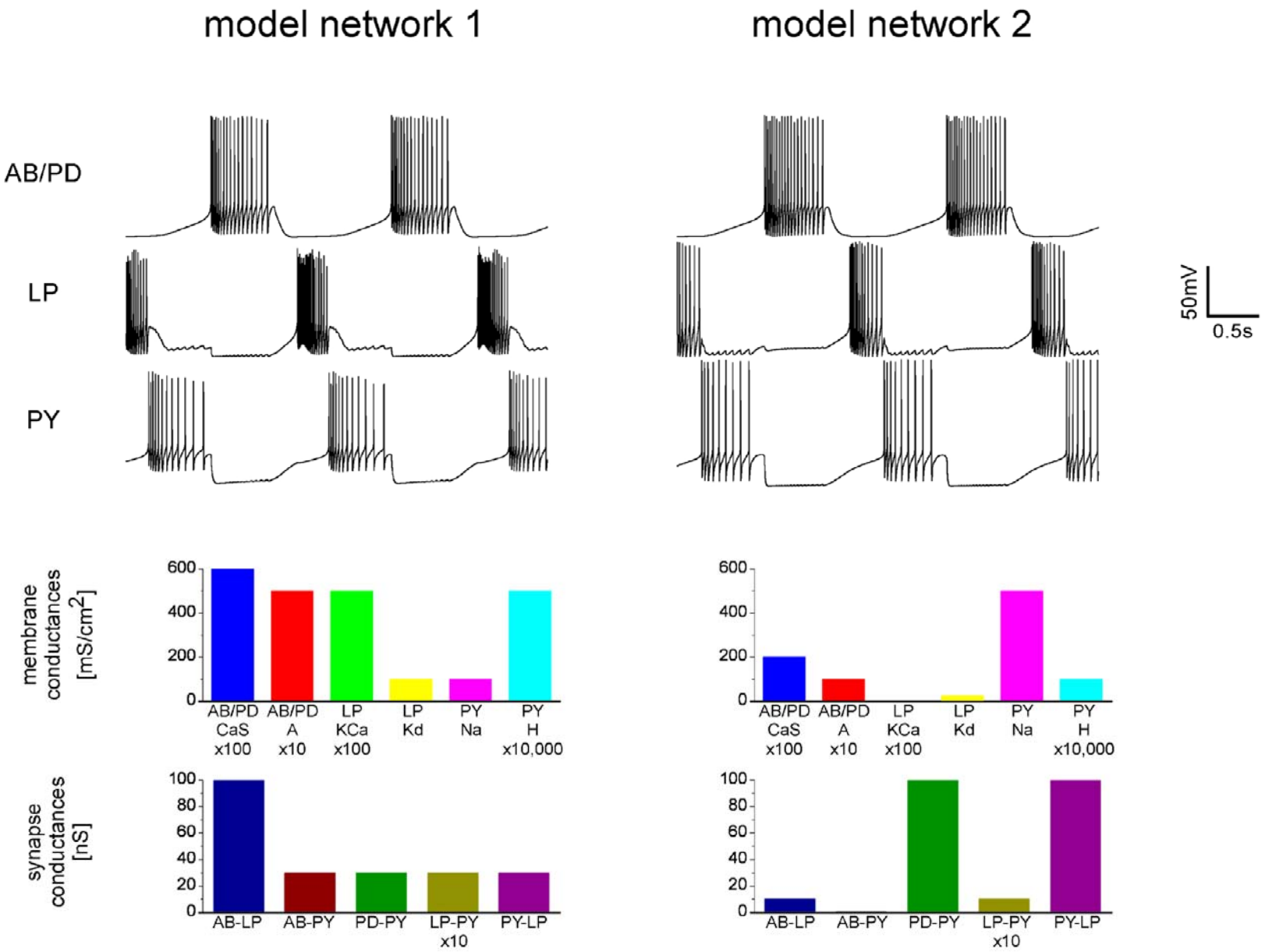






Sharp et al, 1996

Similar network activity; disparate circuit parameters



Prinz AA, Bucher D, Marder E (2004) Nat Neurosci, 7:1345-1352

- Biological systems do not have redundant functions but many overlapping processes that can provide smooth transitions between multiple sets of underlying mechanisms to promote stable function yet allow plastic change.